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PI: Dr. Charles S. Cox

Emphasis in the period since April has been on observations and analysis of thermal structures associated with microturbulence and air/sea thermal processes at the sea surface. Our method of observation is based on an imaging infra-red camera that we have adapted to use from a small boat. The camera responds to radiation in the three to five micrometer wavelength range. This is a useful range because the intensity of black body radiation from the water surface in this range is highly sensitive to the temperature of the source. Typically temperature variations of a few hundredths of a degree are detectable. The camera is mounted on a boom extending forward from the bow of the boat about 1 meter above the water. Our first observations at sea were not satisfactory because sky radiation reflected from the wavy water surface obscured the water temperature signal. This difficulty has been removed by surrounding the camera with an aluminum plate shield that acts like a parasol to make an infra-red shadow on the sea surface. With this apparatus in operation we have observed the microturbulent structures associated with evaporative cooling of the sea surface. The surface strucures show warm pools typically a few centimeters in size, surrounded by narrow lines of cool water. Our interpretation is that the warm pools are broad areas of ascending water and the cool lines are descending. The overall shapes of these structures vary from drawn out figures resembling micro Langmuir cells to more nearly isotropic shapes. The change from isotropic to anisotropic shapes occurs rapidly and so far as we can observe, without relation to driving forces such as waves.

All these oceanic observations have been made in light wind conditions. We are anxiously awaiting an opportunity to continue them when the wind is stronger. In the mean time we have examined some theoretical questions about the evaporation on the scale of molecular processes. When seawater evaporates, the surface is cooled and fresh water leaves as vapor. The result is an increase of salinity in the surface film. Both the lowered temperature and increased salinity diffuse downward in the water, temperature diffusing many times faster than salinity. The result is a gravitationally unstable surface layer which can form in ten or twenty seconds into a thermal layer two or three millimeters thick with salty layer a few tenths of a millimeter thick at the very top. We are planning to examine this vertical structure optically (in the laboratory) to see how long such an unstable layer will persist in the presence of shear and wave motions.